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This was an exploratory study designed to assess the effect of self-referent stimuli on the P300 component of the electroencephalogram (EEG). The stimuli were self-referent phrases. Self-referent phrases are phrases that are personally descriptive, and are, therefore, considered to be personally relevant. Personal relevance was manipulated through the truthfulness of the self-referent phrases. The EEG was examined for the occurrence of the P300 wave of the human event-related brain potential. The P300 is a positive wave of the EEG that occurs 300 milliseconds after the onset of an eliciting stimulus. The P300 was examined for any effects on its amplitude having to do with the truthfulness of the stimuli. The EEG activity was recorded from 20 male subjects who were presented visual stimuli on a computer monitor. The stimuli consisted of five true and five false self-referent phrases. The two-word phrases were repeatedly presented in random order for a total of 300 presentations (150 presentations of the true and 150 of the false). The probability of occurrence of each of the two classes of stimuli was 0.50. The subjects were required to do nothing except read the stimuli. Results indicate that both true and false self-referent stimuli elicited clearly identifiable P300s. The difference between P300 amplitudes elicited by true and false stimuli, however, was not significant ($p > .05$).

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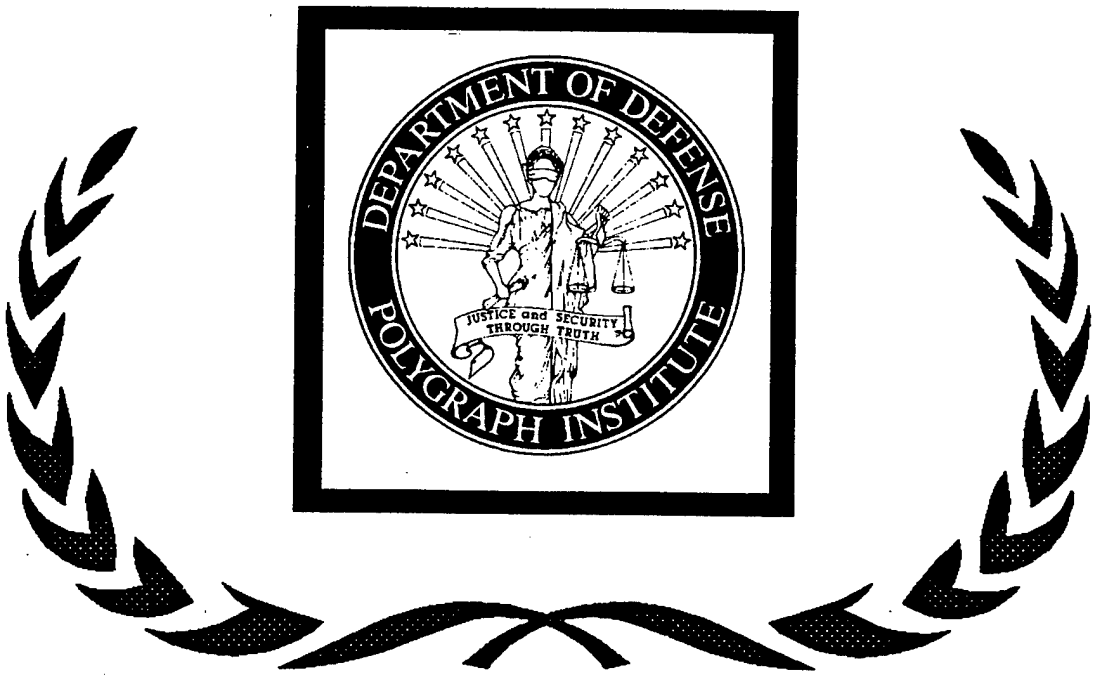

Event-Related Potentials: The P300 and Self-Referent Stimuli

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October 1995

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October 1995

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Director's Foreword

The sensors used to collect physiologic responses during a psychophysiological detection of deception examination have not changed significantly in over fifty years. The advent of electrical amplifiers and digital computers have improved the quality of the recordings, but the physiologic responses actually measured have not changed significantly.

It is possible that physiologic activity which was not reliably measured twenty, or even ten years ago, could be indicative of deception. Advances in technology now permit the reliable recording and analysis of a variety of new responses. One category of such responses includes the components of the electroencephalogram. These include specific waveforms of electrical activity, measured from the brain, which are generated in response to external events. Reports in the recent scientific literature suggest that electroencephalographic activity changes during cognitive processing. Some reports suggest that deception may be identified using these responses. The current, preliminary, study was undertaken to investigate the use of electroencephalographic measures as indicators of deception.

Michael H. Capps
Director

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Abstract

INGRAM, E. M. Event-related potentials: The P300 and self-referent stimuli. July 1994, Report No. DoDPI94-R-0006. Department of Defense Polygraph Institute, Ft. McClellan, AL 36205.--This was an exploratory study designed to assess the effect of self-referent stimuli on the P300 component of the electroencephalogram (EEG). The stimuli were self-referent phrases. Self-referent phrases are phrases that are personally descriptive, and are, therefore, considered to be personally relevant. Personal relevance was manipulated through the truthfulness of the self-referent phrases. The EEG was examined for the occurrence of the P300 wave of the human event-related brain potential. The P300 is a positive wave of the EEG that occurs 300 milliseconds after the onset of an eliciting stimulus. The P300 was examined for any effects on its amplitude having to do with the truthfulness of the stimuli. The EEG activity was recorded from 20 male subjects who were presented visual stimuli on a computer monitor. The stimuli consisted of five true and five false self-referent phrases. The two-word phrases were repeatedly presented in random order for a total of 300 presentations (150 presentations of the true and 150 of the false). The probability of occurrence of each of the two classes of stimuli was 0.50. The subjects were required to do nothing except read the stimuli. Results indicate that both true and false self-referent stimuli elicited clearly identifiable P300s. The difference between P300 amplitudes elicited by true and false stimuli, however, was not significant ($p > .05$).

Key-words: event-related potentials, P300, self-referent stimuli, detection of deception.

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The psychophysiological detection of deception (PDD) has traditionally used multiple autonomic measures of arousal (e.g., electrodermal responses, blood pressure, and respiration) to determine if a person is being truthful. The results of recent research indicate that more direct measures of cognitive activity are available and that these measures may be more powerful tools in the detection of deception (Bashore & Rapp, 1993). These measures are components of the event-related potentials (ERP). Components of the ERP are potentials that are time locked to stimulus onset and are characterized by positive or negative deflections in the voltage of the electrographic signal (Bashore & Rapp, 1993). Donchin, Ritter, and McCallum (1978) point out that these components are labeled according to their electrical polarity and the minimum latency at which their maximum amplitude is attained. A well known component of the ERP is the P300. The P300 is so named because it is a positive component occurring approximately 300 milliseconds after the onset of an eliciting stimulus.

The P300 has been the ERP component most frequently used in current research in detecting the presence of guilty knowledge. Guilty knowledge refers to knowledge about a crime that only the perpetrator of that crime would have. The P300 is, therefore, assumed to be an indicator of the activity of neural subsystems that execute specific information-processing tasks involving higher order mental processes (Donchin, 1981). Thus, the P300 is considered a psychophysiological measure that is a direct manifestation of the neurocognitive processes presumed to be occurring during PDD tests (Bashore & Rapp, 1993). Since these neurocognitive processes are assumed to be involved in the neural storage of information, accessing the processes associated with stored information about the commission of a crime can provide insight into a person's involvement. There have been a few published studies describing the use of the P300 to infer the possession of guilty knowledge (Allen, Iacono, & Danielson, 1992; Allen & Ludwig, 1994; Farwell & Donchin, 1986, 1988, 1991; Rosenfeld, Angell, Johnson, & Quian, 1991; Rosenfeld, Cantwell, Nasman, Wojdac, Ivanov, & Mazzeri, 1988; Rosenfeld, Nasman, Whalen, Cantwell, & Mazzeri, 1987). These studies will be referred to as guilty knowledge approaches rather than detection of deception approaches because they detect the presence of guilty knowledge rather than deception. It is from the presence of guilty knowledge that deception may be inferred.

The guilty knowledge approach is limited in its use to situations in which the examiner has access to the specific details of the crime or event in question. Consequently, in criminal specific tests, stimuli can be selected from items associated with the crime that are known only to the guilty or to those otherwise involved. On the other hand, in screening tests the specific details of a crime are not focused on because the subject is probed about the truthfulness of responses to

questions about his or her background and not about specific crimes. Depending on the situation, questions may be asked about activities such as the use and sale of drugs, theft from previous employers, and criminal activities, such as involvement in felony crimes (Honts, 1991). The questions tend to be global and general rather than focused on specific crimes or events (e.g., have you ever committed...?). Consequently, it would appear that the nature of the questions asked imposes limits on the use of the guilty knowledge approach in PDD testing.

Except for studies by Farwell and Richardson (1993), and Rosenfeld et al. (1991), there have not been any attempts to use ERPs to look at issues related to background investigations. Farwell and Richardson (1993) used ERPs in successfully identifying subjects who were FBI agents and those who were not. Specifically, in this study the P300 was elicited by the presence of information that only agents would have. On the other hand, Rosenfeld et al. (1991), ran what they called a P300 based analog control question test. The test was referred to as a control question test because a pretest consisting of an accusatory phase was utilized. The study consisted of two experiments in which subjects underwent an ERP test. These two experiments differed in the amount of delay between the selection, presentation, and rehearsal of the test phrases and ERP testing (immediate versus 7-12 days). The results indicated that for the P300 to occur consistently, rehearsal and testing had to occur in close temporal proximity. When the delay between rehearsal of the to-be-tested items and testing was 7-12 days, the P300 was not consistently activated to the guilt-related stimuli.

These two studies are mentioned because they address the use of ERPs as they might be used in screening (e.g., asking questions about activities in the individual's background). They also demonstrate that background related issues or events can only be used if they contain the same kind of specificity possessed by crime related events. Finally, they also raise an important question about the proportion of guilt related items to non-guilt related items that can be used in an ERP test. The determining factor of the proportion of critical items to non-critical items is the use of the "oddball paradigm."

In the oddball paradigm, the subject is presented with a series of stimuli and a rule for use in classifying the stimuli into one of two categories. Stimulus probability which is the basis of the "oddball" is determined by the frequency of occurrence of stimuli from each of the two different stimulus classification categories. The subject must respond to the low frequency or rare category of stimuli but not to the frequent category. These rare stimuli are called targets and become task related (Fabiani, Gratton, Karis, & Donchin, 1987). An example of this relationship is to require subjects to press a button or to increment a count each time a member of a specific rare

category of stimulus appears. The frequent stimuli, on the other hand, are called non-targets and the subject must withhold the response to these stimuli. Note that in the Farwell and Rosenfeld studies, only 1 or 2 guilt related items were used per 6 to 10 non-guilt related items. This ratio of guilt related items to non-guilt related items required by the oddball paradigm is problematic when more than a few guilt related items are of interest. Since it would require the use of excessively large numbers of stimuli to maintain the rare-frequent relationship, this requirement acts as a limiting factor to the number of guilt related items that can be used.

Several existing notions suggest a mechanism by which the proportion of guilt related items to non-guilt related items can be increased. First, Stern, Breen, Watanabe, and Perry (1981), and Thackray and Orne (1968), in similar studies questioned subjects about associations varying in degree of personal involvement while recording physiological responses. They found that responses to personally relevant stimuli were of a larger magnitude than responses to non-personally relevant stimuli. Second, Johnson (1988) argues that the P300 is elicited when the brain is activated by the recognition of critical events, and that the amplitude varies as a function of the significance of the stimulus to the subject. Third, a target effect results, according to Donchin, Karis, Bashore, Coles, and Gratton (1986) and Johnson (1988), when the probability of occurrence for two separate stimuli becomes equal and the amplitudes of the P300 elicited by the target is slightly larger (several millivolts). An equivalent of the target effect occurs when two sets of non-task stimuli equal in probability of occurrence, but differing along some dimension significant to the subject are used. Any difference in the P300 in this situation would be due to a difference in the inherent significance of the stimuli rather than to the stimulus having been designated a target by assigning a task to it. Finally, Bashore and Rapp (1993) argue that the P300 may be sufficiently robust in its own right to obviate the need to embed the crime-stimuli in the context of some broader task as in Farwell and Donchin (1991). Thus, the robustness of the P300 and the effect of stimulus significance would make the use of the oddball paradigm unnecessary and, consequently, allow an increase in the number of potentially incriminating items that could be assessed at any one time. In a screening context these could be self-incriminating items such as "participated in espionage," "stole secrets," or "used drugs."

Therefore, the significance of true versus false phrases allows examination of the significance issue as well as self-incrimination without the potentially confounding effect of deception. Note that the subjects in the Farwell and Donchin (1991) study were not actually allowed to be overtly deceptive. They simply were required to press different buttons to the occurrence of different classes of stimuli. Deception was

inferred from the occurrence of a P300 response to the presence of critical stimulus items in memory. In the case of research reported here the important issue is whether or not the P300 can be used to distinguish between true and false self-referent information. In the event that true autobiographical stimulus items hold greater significance than untrue items and elicit significantly larger P300s, a potentially useful screening tool would be provided.

This study was conducted to address two questions. First, is the personal relevance of self-referent stimuli sufficiently robust for personally relevant stimuli to elicit P300s in a non-oddball paradigm? Second, are true phrases sufficiently significant to elicit larger P300s than false phrases?

Two hypotheses were derived from the above questions. The first hypothesis was that the P300 is sufficiently robust that it will be elicited by self-referent stimuli in a paradigm with no assigned task, and with equally probable stimulus categories. The second hypothesis was that the more significant true, self-referent stimuli will elicit larger P300s than false self-referent stimuli.

Method

Subjects

Twenty-eight, native English speaking, healthy males (mean age = 28.3; standard deviation = 6.7 years; range = 19 to 39) volunteered to serve as participants in this study. The volunteers all came from the population of U.S. Army trainees at Fort McClellan, Alabama. All volunteers reported themselves to be healthy and medication free. Females did not participate in the study due to a lack of availability in the source population at the time of the study. The data for eight subjects were omitted from the analysis due to a computer software malfunction. This malfunction was remedied by the use of a later version of the recording software.

Apparatus and Psychophysiological Recording

EEG was recorded, using 10 mm Grass E5GH gold plated electrodes and Grass EC2 electrode paste from Grass Instruments Company of Quincy, Massachusetts. The electrodes were located at midline positions Fz, Cz, and Pz, with a ground in the center of the forehead. Electrode placements were made according to the International 10/20 system (Jasper, 1958). All electrodes were referenced to linked electrodes attached to both mastoids. Since recordings were made only from midline positions, the electro-oculogram (EOG) was recorded only from electrodes placed above and below the right eye. EOG activity of 10 microvolts or less was suppressed by providing a fixation point prior to stimulus presentation (Hillyard, 1974). EOG artifact correction procedures consisted of the application of a method developed by

Semlitch, Andrer, Schuster, and Presslitch (1986). The artifact correction procedure was applied to each response by the NeuroScan system version 3.0 by NeuroScan, Incorporated of Herndon, Virginia. Electrode impedance did not exceed 5 Kohm. Input from all electrodes was passed to a Grass Model 12 Neurodata Acquisition System amplifier bank (Grass Instruments Company, Quincy, Massachusetts). The Grass Neurodata Acquisition System provided amplification of 20,000 for both EEG and EOG signals. Filters on the grass amplifiers were set with low and high-pass values at one-half amplitude frequencies of 30 and 0.03 Hz, respectively (Pass band frequency was from .03 to 30 Hz). No 60 Hz notch filters were used. The EEG and EOG signals were digitized at a rate of 256 samples per second by the NeuroScan system.

Design

In order to approximate a screening type of situation, the subjects would perform some type of activity and then return to the laboratory several or more days later for testing (i.e., testing for events that occurred in the past). Since it was not feasible due to concerns regarding subject availability to have subjects return repeatedly to the laboratory for testing, stimuli were chosen from events determined to be present in the subjects' backgrounds. In this case the stimuli were declarative phrases (i.e., "college graduate," etc.) similar in form to those successfully used by Rosenfeld et al. (1991). Since these stimuli refer to states or situations that characterize the person, (e.g., "Medical Doctor," "U.S. Marine," etc.) they are inherently significant. This approach would allow an inference to be made regarding the presence or absence of deception in an individual's statements about the occurrence of events or activities in their background. This inference would be based on a comparison of the P300 responses to stimulus items asking about these events or activities.

In this study 28 subjects underwent a no task condition in which each stimulus category was presented with equal probability of occurrence (probability = .50). Subjects were not required to perform any task except to silently read the stimulus phrases. The independent factor in this study was the truth of the stimulus items, and the dependent factor was the P300 amplitude. The stimuli consisted of two-word phrases containing personal or self-referent information, half of the stimulus information was true for the subject and the other half false. The stimuli were white letters presented on the black background of a 14-inch (diagonal) computer monitor (CTX model CVP-5468A VGA, by CTX International, Walnut, California). Each subject received a total of 300 stimuli (150 presentations of the true and 150 presentations of the false stimuli). The stimuli subtended 1.5 degrees of vertical visual angle and 9.5 degrees of horizontal visual angle. Stimulus duration was 1000 ms with an interstimulus interval of 1500 ms. Thirty second rest periods

occurred after each 100 stimulus presentations. The use of the EOG artifact correction algorithm precluded the necessity of excluding from analysis those trials in which eye-blinks exceeded some critical value. The stimulus list is shown in Appendix A.

Procedure

Upon arrival at the Department of Defense Polygraph Institute, subjects were met by a DoDPI laboratory assistant and taken as a group to a room adjacent to the laboratory where they were briefed on the purpose of the investigation and given a full explanation of the procedures. Appendix B contains a copy of the justification and explanation sheets that were given to all subjects. Subjects were then asked to read and sign a volunteer affidavit which informed the subjects that their participation was solely voluntary. (See Appendix C for a copy of this form.) Upon completion of the introduction and the signing of the volunteer affidavit, the subjects were required to complete a personal information form, a copy of which is contained in Appendix D. Information from this form was used in the construction of the true and false stimulus items used in the study.

The subjects were escorted one at a time (one subject per session) to a laboratory at DoDPI, where the recording electrodes were attached. The subjects were then required to sit quietly with eyes open in front of a computer monitor. The monitor was positioned 90 cm from the subjects eyes at a height of 100 cm (floor to screen center). The subjects were allowed to adjust the monitor to their desired comfort level. Each subject was read the following instructions:

> You are to sit here in front of the computer screen where you will focus your eyes on the cross at the center of the screen. Once we start the experiment a different number of two-word phrases will appear on the screen in place of the cross. I want you to read the phrases silently. They will be personal type phrases, that is, they are phrases that characterize people, which means that they are phrases that say things about a person. The things that they say can be either true or false. We are going to show you some phrases like that, which say something about you. What we want you to do is read the phrases. Read each one silently to yourself. You won't be required to do anything like read aloud or press a button. After a few minutes we will stop and take a break, and you can stand and stretch and have a drink of water if you so desire.

At this point each of the answers given on the subject's personal form that were to be used as stimuli were discussed with the subject to assure accuracy. The subject was then told:

> Now, after you finish this part of the study, I want you to tell me what you read. Once the experiment starts, I would, also, like for you to: (a) Please sit as still as possible until told that you can move about. (b) Be sure to focus your eyes on the small cross when it appears on the center of the screen. (c) Try and blink your eyes only when the cross is on the screen, otherwise try not to blink your eyes. (d) Do not clench your jaw or grit your teeth. (e) Try to relax and not tense your body. And (f) remain awake.

At this point, if there were no questions, stimulus presentation began. During the experimental session a frontal view of the subject was transmitted to a monitor visible to the examiner by a video camera positioned behind the stimulus presentation monitor. This arrangement was used by the experimenter to note any activity made by the subject. The sessions were not recorded. The examiner sat directly behind the subject at a distance of approximately 2 meters. After the completion of the test session the subject was debriefed, but not required to sign a form. The debriefing consisted of answering, when possible, questions that the subject had, and requesting that the subject not discuss the study with anyone.

Data Reduction

P300 components were identified visually using each subject's grand average. The P300 component was defined as the greatest positive voltage occurring between 300 and 800 ms after stimulus onset. P300 amplitudes were calculated by subtracting the average voltage measured 100 ms prior to stimulus onset (baseline) from the amplitude of the P300 component. Since this was primarily an exploratory study this peak selection approach was considered to be adequate, since the physical characteristics of the P300 are fairly well known, and visual identification methods will most likely be used in any future implementation of the P300 in lie detection.

Results

Each subject's averaged ERP response to the two stimulus categories was based on 150 presentations of the true stimuli and 150 presentations of the false stimuli. A comparison was made between the grand means for the baseline-to-peak averaged P300 amplitudes elicited by the true and the false stimuli ($N = 20$). Figure 1 shows the grand mean waveforms from the three electrode positions. The effect of true versus false stimuli on the averaged ERP was assessed using a stimulus type (true/false) x electrode position (Fz, Cz, and Pz) repeated-measures analysis of variance. The main effect of stimulus type (true/false) was not significant [$F(1, 19) = 4.02$, $p > .05$]. The main effect for electrode position was significant, $F(2, 38) = 11.33$, $p < .001$; power = 1.00. The stimulus type by electrode position

interaction was not significant, $F(2, 38) = 2.79$, $p > .05$; power = .16. Power was computed using Stat-Power (Bavry 1991). The baseline-to-peak mean P300 amplitudes can be seen in Table 1. Table 1 also shows the differences in amplitude between the true and the false stimuli in mean baseline-to-peak amplitude.

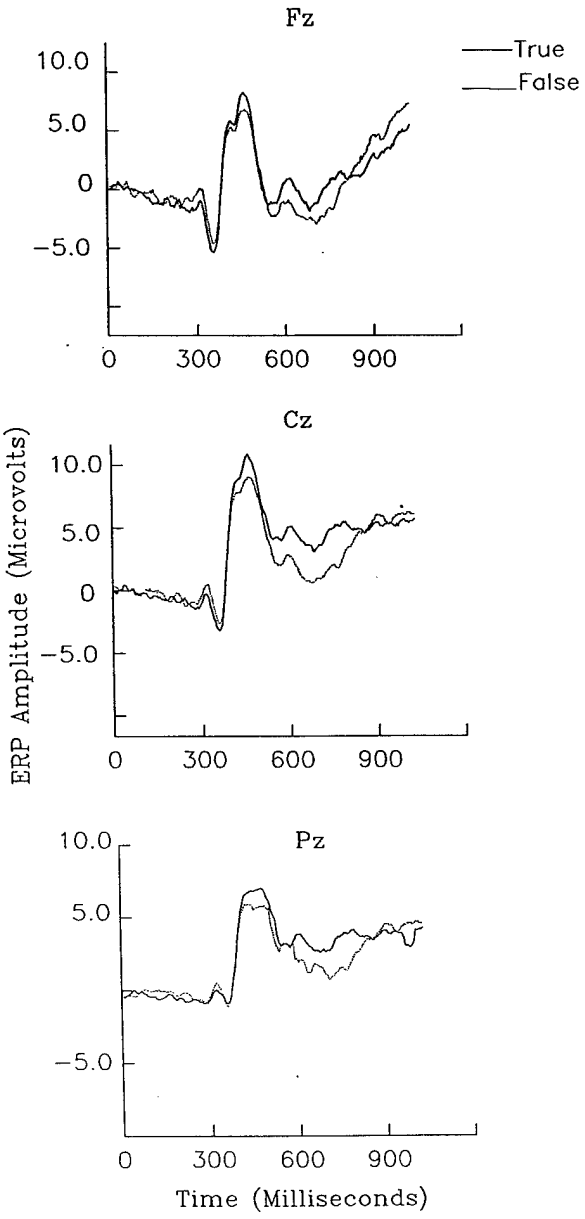

Figure 1. Grand average P300 ERPs in response to true and false stimuli measured from Locations FZ, CZ, and PZ.

With regard to the significant main effect of electrode position, the Tukey pairwise comparisons procedure (Stevens, 1992) was performed. The results of this test indicated that the P300 amplitudes at Cz were significantly greater than at Fz for both true and false stimuli. This relationship can also be seen in Table 1. A slight, but nonsignificant, difference in amplitude between the true and false stimuli can be seen in Table 1. Figure 1 shows the grand means for both sets of stimuli at all three electrode locations. The small differences in peak amplitude between the true and the false stimuli can be seen in Figure 1. However, a visual examination of each subject's averaged ERPs to both the true and false stimuli shows that a greater amplitude response occurred to the false response in some cases. The grand mean waveforms at each electrode position for both true and false stimuli for each subject are shown in Appendix E.

Table 1
Mean Peak Amplitudes in Microvolts as a Function of Stimulus Type and Electrode Position

	Electrode Position		
Stimulus Type	Fz	Cz	Pz
True Words Phrases			
M	7.937*	11.232*	9.089
SD	2.703	3.047	3.789
False Word Phrases			
M	7.135**	9.840**	8.745
SD	2.624	3.539	4.327

Note. Means with the same number of asterisks are significantly different from each other at $p < .05$.

Discussion

Two hypotheses were tested in this study. The first hypothesis was that the P300 is sufficiently robust that it will be elicited by self-referent stimuli in a paradigm with no assigned task, and with equally probable stimulus categories. The second hypothesis was that true self-referent and personally relevant stimuli would elicit larger P300s than false self-referent and personally relevant stimuli.

It was found that, in support of the first hypothesis, both categories of stimuli elicited P300s. Additionally, the significant effect of electrode location is consistent with the scalp distribution of the P300. It is largest at the parietal and sometimes at the central electrode, and smallest at the frontal electrode (Johnson, 1988). The significance of the

finding that the oddball paradigm is not necessary to elicit a P300 is that the potential use of more varied experimental designs will be allowed in the attempt to assess deception with the P300. On the other hand, differential responding between the true and false stimuli was insufficient to support the second hypothesis. Since subjects were not required to perform an attention focusing task such as a button press, it is surmised that the characteristics of the stimuli themselves provided the primary basis for responding. Failure to provide the subjects with a behavioral response requirement did, however, provide a threat to validity by reducing the probability that subjects were attending solely to the stimuli. With this problem in mind an alternative approach could have been to require subjects to press a response switch to both stimuli. In order for this to have been a useful approach, subjects would have had to have been instructed to classify the stimuli (i.e., press the right button to true stimuli and the left button to false stimuli). This requirement would have added task significance to the stimuli which could then have been confounded with any inherent relevance attached to the stimulus. Consequently, we relied on the subject's adherence to instructions and their post session reports to assess their attentiveness during the session.

One likely source of explanation for the occurrence of the P300 to both types of stimuli is the context updating model of the P300 (Donchin, 1981; Donchin & Coles, 1988). This model proposes an explanatory mechanism for the elicitation of P300s by stimulus events. According to the model, the P300 is a manifestation at the scalp of the information processing brain activity that reforms or revises the "cognitive schema." This "cognitive schema" is an internal representation of the individual's immediate environment. This process is implemented when the individual is presented with information that is either rare, unusual, task-relevant, noteworthy, or significant to the individual. Within this model several approaches to significance are developed. These approaches consist of concepts of meaningfulness having to do with actual monetary value; task relatedness, and particular background experiences not involved in any experimental task (Donchin, 1981; Farwell & Donchin, 1991; Johnson, 1986). This study focused on whether or not stimuli with a particular significance to the subject as a result of past experience would expand the schema and result in larger P300s. Since the stimuli used in this study were neither rare, unusual (did not refer to extremely uncommon situations), nor task related, the P300 etiological possibilities are limited to stimulus meaningfulness based on personal relevance. Personal relevance is assumed from the nature of the stimuli. It is assumed that self-referent stimuli (stimuli describing the individual in some way unique to the individual in a specific context) come to be personally relevant. Even false descriptive stimuli can be considered personally relevant since they are verbal descriptions of the subject (the pre-test instructions

told the subject that the stimuli were to be about him). Therefore, stimuli that are personally relevant based on their self-referent character should meet the criteria of significance in the model.

One factor that could account for the lack of significant differential responding is that the comparison between true and false, descriptive, self-referent stimuli was not actually a comparison between relevant and irrelevant stimuli. The subjects apparently saw both stimulus sets as relevant. As far as self-irrelevant or personally irrelevant stimulus are concerned, once a stimulus acquires some aspect that designates it as being about the individual's self it assumes relevance to the individual. Thus, the distinction self-important and self-unimportant might be regarded as somewhat more explanatory where one is attempting to make distinctions regarding stimulus importance. Moreover, as we can see in the results of this study, true phrases may be self-important but false phrases are not necessarily self-unimportant. However, the distinction that provides the best comparison and is more appropriate is the significance dimension. In the significance dimension, meaningfulness is related to information necessary for the performance of a task (Johnson, 1986). Consequently, in this context, both categories of stimuli were likely to be equally significant since both were equal in lack of task relatedness, and possibly in the degree of self-relevance.

A second factor worth consideration in contributing to a lack of significance is the occurrence of a stimulus categorization process to both sets of stimuli that stemmed from subjects reading them. Categorization of relevant stimulus events is a basis for P300 generation. When a categorization rule develops (i.e., these items are true and these items are false), the inherent significance of the stimuli may have been insufficient to produce significant amplitude differences. A number of subjects (13 subjects) reported that they saw two sets of stimuli, and some indicated that when they read a phrase they "called" it true or false or "me or not me." Assuming that subjects were busy categorizing each stimulus and with the significant role that it plays in P300 generation, it is likely that personal relevance was overshadowed.

A third factor possibly accounting for the failure of differential responding between true and false stimuli may stem from the P300s lack of specificity to semantic stimuli. The P300 is known to occur to both physical as well as semantic characteristics of the stimuli (Kutas & Hillyard, 1983). Work by Kutas and Hillyard (1983), has shown that another component, the N400 component may be worth consideration at this point since it is known to occur to specific semantic aspects of the stimuli.

The N400 was first described by Kutas and Hillyard (1980) to be extremely robust and to be invoked by semantic anomalies in both visual and auditory modalities. They compared ERPs to words that completed sentences in an unexpected way with ERPs to words that completed sentences in expected ways. For the unexpected endings, they found a negative wave occurring approximately 400 ms after onset of the final critical word. For the expected ending, they found no negative component. These responses have been shown to occur only to phrase endings that have a semantic or linguistic nature, but not to phenomena such as grammatical correctness (Kutas & Hillyard, 1983). Of even greater significance is the finding that the N400 is elicited by words that end a declarative sentence falsely but not by words that complete such a sentence truthfully (Fischler, Bloom, Childers, Roucos, & Perry, 1983). Boaz, Perry, Rany, Fischler, and Shuman (1991) had subjects view video tapes of either an enacted burglary (guilty condition) or scenes from New York City (innocent condition). Subjects then read crime related statements that had true or false completions. Using N400s elicited by the terminal word of the phrases, the authors were able to classify correctly 78% of subjects. Taken together, the research on the N400 component and on cognitive processes suggests that if a person has crime relevant or issue relevant information, an N400 should occur in response to false statements as opposed to true statements involving that knowledge. When a person has no such knowledge differential N400s should not be elicited. Despite its apparent promise an assessment of the N400 was not within the scope of the research reported here. Nevertheless, it does definitely merit further exploration along with the P300.

The N400 would allow the examiner to directly evaluate the subject's response to self-referent statements (i.e., You are a saboteur, etc.). By directly evaluating self-referent statements, the examiner would not need to create crime related stimuli. There also would not be the need to create an oddball paradigm to avoid calling the subject's attention to the relevant stimuli. Based on the nature of the N400, calling attention to the relevant issue doesn't appear likely to be a problem except that possible effects of high arousal levels need to be examined. High levels of arousal may be associated with self-incrimination in events of a serious nature and to the use of highly inflammatory statements such as in the above example.

The significance of this research, as it regards the detection of deception, is that it points to some aspects of using the P300 that may limit its utility as a screening tool to very specific screening situations. Specifically those situations where the information that is to become the stimuli are specific and closely related to a crime or activity under consideration. In addition the absence of deception in the experimental paradigm used in this study does limit the

generalization of the results somewhat. The research does, however, suggest that passively withheld information (information that the subjects possess, but has not been asked about) can be tested for. Therefore, the individual may not have to actually engage in deceptive behavior for the presence or absence of the desired information to be determined. Further significance of this research is also seen when one considers that the task facing the researcher is to understand the antecedent conditions (Donchin & Coles, 1988) and the functional significance of the component that one has hopes of utilizing. This understanding will alert researchers to the influence of neural processes on the manifestation of the component, and allow researchers to construct scenarios in which the reliable evocation of the component can be predicted and therefore, utilized.

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Appendix A

Stimuli used in the Experiment

Category:

True	False
1. Married Now (if married) or Unmarried Now (if unmarried)	1. Airline Pilot
2. Army Trainee	2. Army Officer
3. Named _____ (first name)	3. Soviet Citizen
4. U.S. Citizen	4. Named _____ (incorrect first name)
5. _____ native (Home state)	5. _____ native (Incorrect state)

Appendix B

Description of the Research

To You, the Participant

Welcome to the Department of Defense Polygraph Institute. This may be the first time you have been to the Institute so we would like to provide you with some information concerning the purpose for your being here today. We hope that you will enjoy the task we will give you today. Your participation is completely voluntary. If you have any questions, please feel free to ask the investigator who greets you today.

Part A -- Explanation

1. Project Title: Event-Related Potentials: The P300 and Self-Referent Stimuli

This project is being conducted by the DoD Polygraph Institute, Fort McClellan, Alabama.

2. PRINCIPAL INVESTIGATOR: Dr. Eben M. Ingram, Research Psychologist, DoDPI.

3. DISCUSSION: Congress has directed the Department of Defense to conduct research to determine the effectiveness of the polygraph. Part of this mandate requires that new and existing polygraph procedures be tested for accuracy and reliability. You are being asked to volunteer for an investigation that will help us investigate the accuracy of this specific polygraph test.

You may or may not be asked to be involved in a mock crime scenario. If you are asked to participate in a scenario, then you will be asked to follow certain instructions from a staff member. After following those instructions, you will be asked to take a polygraph examination. If you are not asked to be part of any scenario, then you will be taking a brief polygraph examination regarding a matter in which you will obviously have no direct involvement.

4. DISCOMFORTS: Some people find it difficult to sit still for several minutes at a time during the polygraph test, while psychophysiological measurements are being made from the body. However, since the actual polygraph tests run for a couple of hours you will be given break periods. The total length of time required for your participation in this investigation will be approximately 2 hours, but we require that you be here at the Institute for the entire day.

5. VIDEOTAPING: All examinations conducted during this project may be videotaped, and should they be so you will be informed. If the session is recorded, the tapes will be collected and will be maintained until the operational and data analysis portions of this project are complete. At that time the video tapes will be made available for re-use by the research and instruction divisions.

6. RISKS: There are no known risks involved in this study.

7. CONFIDENTIALITY OF RECORDS: Except for admissions to committing an actual crime of a serious nature or violations of national security, all of the information that you will tell the examiners is confidential information and will not be revealed to anyone not directly involved in the research. Admissions of any serious crimes or breaches of national security will be reported to the proper authorities for investigation.

In the absence of any such admissions, all videotapes and paper documents associated with your examination will be used for research purposes only. Members of the U.S. Army Surgeon Generals's Human Subjects Research Review Board may inspect the records of the research in their capacity as reviewing officials, but your identity will be kept confidential.

8. YOUR RIGHTS: You have the right to ask any questions about any aspect of your participation in this study. If any problems arise at any time in conjunction with your involvement in the study, or if you have been injured in any way as a result of the study, the person to contact is the chief of the research division of the Defense Polygraph Institute. In the event that you do have questions or any of the above has occurred please contact Dr. Yankee at (205) 848-3803. Should any question arise concerning study-related injury, you may contact the Director of the Noble Army Community Hospital, Fort McClellan, Alabama, 36205, telephone number (205) 848-2200.

9. VOLUNTARY PARTICIPATION: Your participation in this study is completely voluntary. If you would prefer not to participate, do not volunteer for it! Even if you decide to participate in the study, you may discontinue at any time without penalty or loss of benefits to which you are entitled. Should you decide not to participate please inform someone on the staff at the Defense Polygraph Institute, or if it occurs during the polygraph examination itself, inform the examiner and you will be released and returned to your unit.

Appendix C

Volunteer Agreement Affidavit and Personal Statement

This form is affected by the Privacy Act of 1974.

1. AUTHORITY: 10 USC 3012, 44 USC 3101 and 10 USC 1071-1087.

2. PRINCIPAL PURPOSE: To document voluntary participation in the Defense Polygraph Institute Research Program. Your name will be used for identification only.

3. ROUTINE USES: The name will be used for identification and locating purposes. Information may be furnished to Federal, State, and local agencies.

4. MANDATORY OR VOLUNTARY DISCLOSURE: Your signature is necessary if you want to be included in this research. If you do not sign, you will not be able to serve in this study and you will be returned immediately to your Unit.

PERSONAL STATEMENT

I, _____, being at least 19 years old, do hereby volunteer to participate in a research study entitled Event-Related Potentials: The P300 and Self-Referent Stimuli being conducted by the Department of Defense Polygraph Institute (DoDPI) at Fort McClellan, under the direction of Dr. E. M. Ingram.

1._____I understand that I am participating in a research study to examine several measures and techniques some of which are may become employed in criminal polygraph situations.

2._____I am aware that I will be spending between four (4) and eight (8) hours at DoDPI and that during this time I may be asked to participate in research requiring the recording of bodily activities.

3._____I understand that as a part of this study, I will be taking some form of a simulated polygraph examination, during which I will be asked to sit still for long periods at a time during the test, while psychophysiological measurements are being recorded from my body.

4._____I understand that there are no known dangers or risks arising as the result of my participation in this study.

5._____I understand that I may be videotaped during the polygraph examination and that the videotape will be maintained for additional study. However, I will be told if I am videotaped.

6._____I understand that I will receive no reward or benefit of any kind as the result of my participation in this study.

7._____My participation, the nature, duration and purpose of the investigation and the methods by which it is to be conducted, have been thoroughly explained to me. I have been given the opportunity to ask questions concerning this study, and any such question has been answered to my satisfaction.

8._____I understand that I may terminate my involvement in this study at any time and for any reason.

9.____I understand that any admissions concerning a breach of national security or of crimes of a serious nature may be reported to the appropriate authorities.

10._____Should I have any concerns or complaints concerning this study, I understand that I may contact Dr. Eben M. Ingram, or Dr. William Yankee at (205) 848-3803

11._____Should any question arise concerning my rights relating to study-related injury, I should contact the Director of the Noble Army Community Hospital, Fort McClellan, Alabama, 36205, telephone number (205) 848-2200.

_____ _____
Signature Date

_____ _____
Print your name here WITNESS

_____
Witness's Name Printed

Appendix D

Demographics

Subject # _____ Date_____/_____/_____

Age _____

Gender 1- Male 2- Female

Race: 1 - African-American 2 - Caucasian 3 - Hispanic
4 - Asian 5 - Native American
6 - Other (Specify) _____

Education Level: Check the highest level an indicate the number of years completed and degree awarded if appropriate.

( ) High School _____
( ) Technical/Vocational _____
( ) College _____Degree _____
( ) Post-Undergraduate _____Degree _____

Family Background: (Age, POB, and occupation of each)

Mother_____
Father_____
Sister(s)_____
Brother(s)_____
Spouse_____
Children_____

Military Service: If____Permanent Party, give Rank_____, Year of entry____, Service_____

If____Trainee, Week of training?_____

Health Status How would you describe your present health and physical status?
( ) Excellent ( ) Good ( ) Fair ( ) Poor

Are you presently under a physician's care? ( ) No ( ) Yes

Are you taking any medication? ( ) No ( ) Yes

If yes, for what condition? _____

What is the medication that you are taking?_____

Do you feel any Pain/Discomfort today?

1 - None 2 - Not Bad 3 - Mild 4 - Moderate
5 - Bad 6 - Very Bad

Reason for pain or discomfort_____

Physical Fitness: Prior to coming to Ft. McClellan, did you participate in regular fitness/exercise?

( ) Yes ( ) No

Sleep: How much sleep did you get last night?_____

Arrest Record: Offense Date, Type: Civ/Mil.

Leisure Activities:

_____

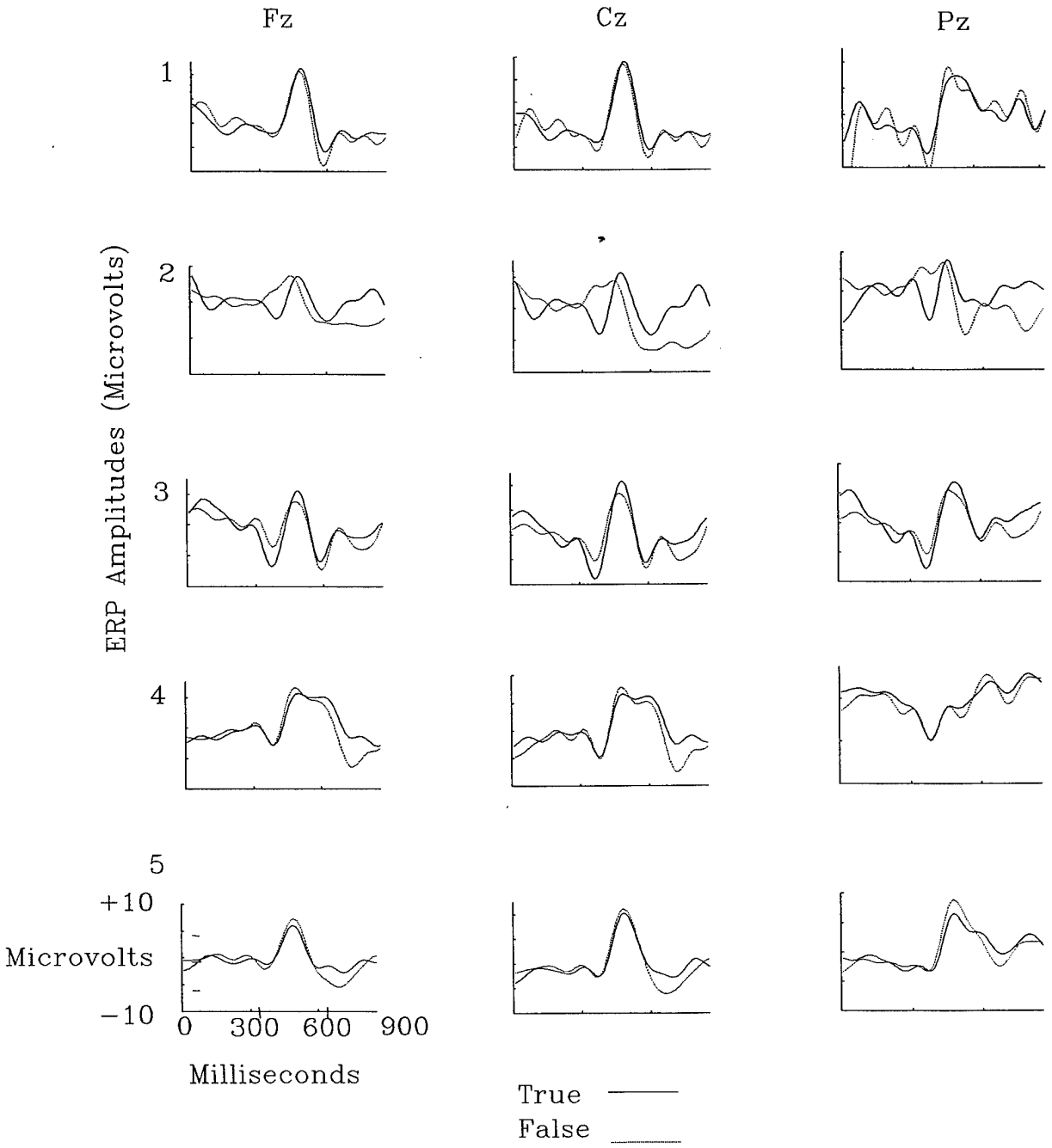
Substance Use: Used within the last 48 hours.

Narcotics/Drugs_____
Caffeine_____
Alcohol_____
Tobacco_____
Medicines_____

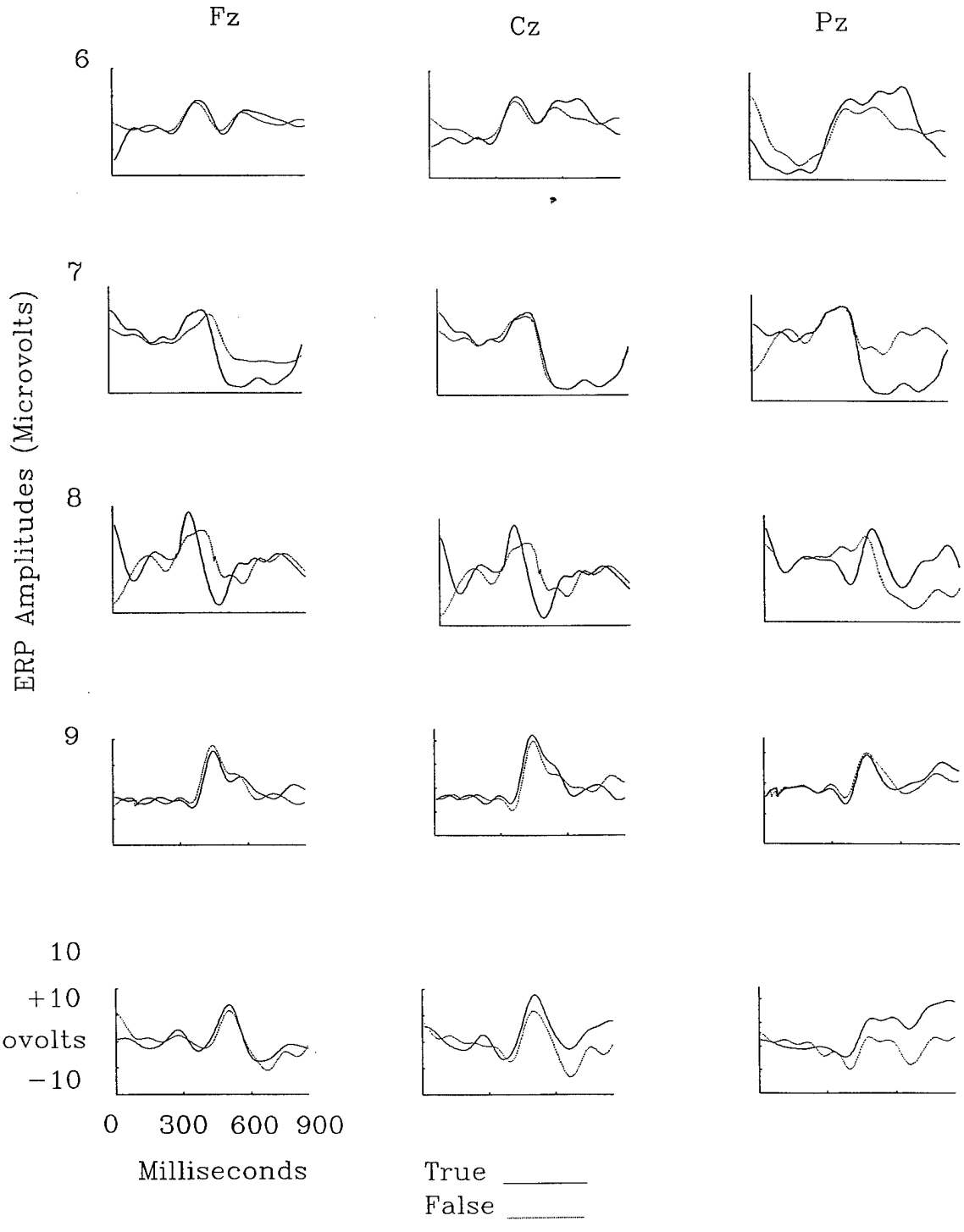
Comments:

Appendix E

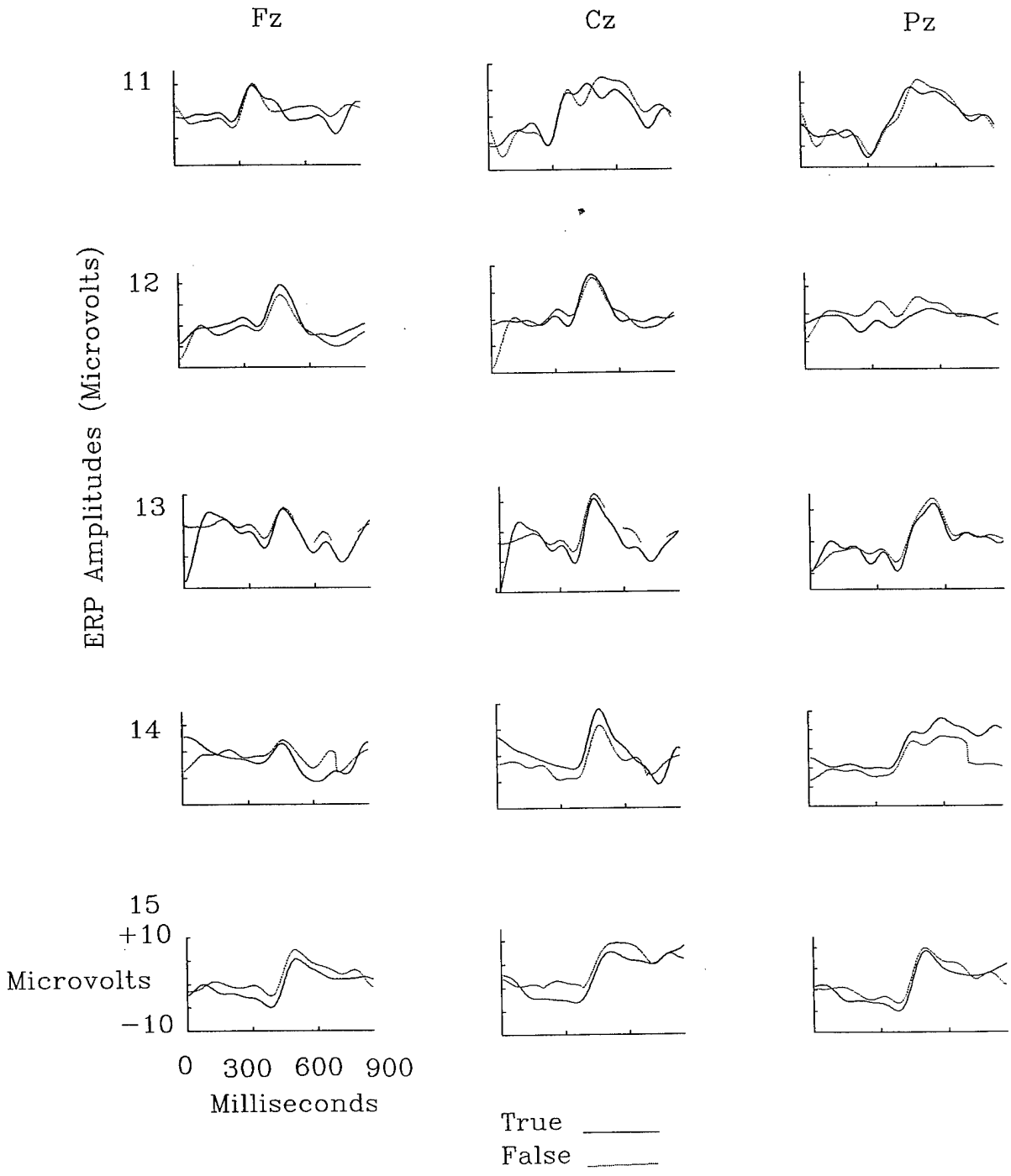
Grand mean ERPs for subjects 1 through 5 at Fz, Cz, and Pz.



Grand mean ERPs for subjects 6 through 10 at Fz, Cz, and Pz.



Grand mean ERPs for subjects 11 through 15 at Fz, Cz, and Pz..



Grand mean ERPs for subjects 16 through 20 at Fz, Cz, and Pz..